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A CRITIQUE ON DUTHIE'S FLORA OF THE UPPER GANGETIC PLAIN

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ABSTRACT

The base of the Himalaya has failed to provide a workable boundary for the Flora of the Upper Gangetic Plain. Climatically, the sub-mountainous tracts are similar to the Himalayan region and differ markedly from the plains which are drier. Floristic composition of the Himalayan region and that of the sub-mountainous tracts is similar and a large number of plants included in Duthie's Flora are from these tracts. It is well known that mountainous plants have a wide altitudinal range of distribution and some of these may also be present in sheltered pockets in the submountainous regions but they very rarely reach the hot Gangetic Plain. A list of such plants to support this observation is included.

The base of Siwalik with a definite altitudinal limit is proposed as a more natural, workable boundary for the Upper Gangetic Plain, thus excluding the sub-mountainous tracts. This will result in a compact and stable flora. The inclusion of the sub-mountainous tracts in the Himalayan region will avoid duplication and will also mean lesser new records or additions to such a Flora.

THE FLORA OF THE UPPER GANGETIC PLAIN

The Gangetic Plain is one of the well defined botanical provinces of India. The part of the Plain lying to the West of the border with Bihar is generally regarded as the Upper Gangetic Plain. Duthie who wrote the Flora of the Upper Gangetic Plain, incorporated in it the areas adjacent to it in the Siwalik and sub-Himalayan tracts. The inclusion of these additional areas, while enlarging the scope of the Flora resulted, however, in the introduction of heterogeneous elements into an otherwise uniform flora of the plains. Duthie was aware of this aspect and, in the preface to his Flora, expressed his views in the following words: "The inclusion of Dehra Dun, as well as of other portions of submontane tracts of Garhwal, Kumaon and Nepal, may be objected to as being an encroachment on the Himalayan region, but the difficulty was to find any continuous and workable boundary line outside the base of the Himalaya proper".

The author of this article, who has been actively engaged in the study of the local flora, particularly of the Dehra Dun Valley, for the past several years has, by his detailed observations, come to the conclusion that the base of the Himalaya has failed to provide any workable boundary for a proper appreciation of the Flora of the Upper Gangetic Plain. At this time, when the rewriting of the regional floras is being contemplated, it was felt that attention should be focussed on this problem and a positive attempt made to clearly define the limits of the Flora so that any phytogeographic incongruities are avoided. The present account has been written mainly from this point of view.

Floristically and climatically, the Dehra Dun Valley, Siwaliks and other sub-Himalayan tracts are part of the Himalayan region and cannot be easily separated from it. An examination of Table I, indicates that the monthly and annual precipitation which exerts considerable influence in determining the vegetation of a region, is practically the same in the two regions, whereas it differs markedly from the conditions in the plains. The latter region "is poorest in its vegetation owing to the dryness of climate" (*Parker* 1918). The sub-mountainous region on the other hand, merges with the Himalaya with no sharp line of distinction and is also, botanically, the richest with a subtropical flora.

A critical analysis of the elements included in Duthie's Flora, reveals that a large number of plants are recorded exclusively from Dehra Dun and other sub-mountainous tracts. Most of these are commonly met with in the adjacent Himalayan region but are not seen in the Indo-Gangetic Plain. To illustrate this point, the family Ranunculaceae may be considered. 10 species of the family have been recorded for the flora, 7 by Duthie and 3 subsequently added by Raizada. Of these, only 2 are found in the Gangetic Plain while 9 are found in the sub-mountainous tracts, only one being

TABLE I : *Normal monthly and annual rainfall (in millimetres/inches)*

Station	Elevation	Zone	January	February	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Yearly
Mussoorie	2080 m (6940′)	Himalaya	68.8 (2.71)	86.6 (3.41)	57.4 (2.26)	33.8 (1.33)	42.4 (1.67)	223.0 (8.78)	699.5 (27.46)	694.4 (27.34)	252.7 (9.95)	29.0 (1.14)	4.3 (0.17)	35.1 (1.38)	2225 (87.6)
Dehra Dun	669 m (2239′)	Sub Himalaya	58.9 (2.32)	62.7 (2.47)	32.0 (1.26)	16.5 (0.65)	36.8 (1.45)	217.2 (8.55)	668.0 (26.30)	731.3 (28.79)	269.7 (10.62)	32.0 (1.26)	8.9 (0.35)	25.9 (1.02)	2160 (85.04)
Agra	166 m (553′)	Indo Gangetic Plain	12.9 (0.51)	12.5 (0.48)	8.1 (0.32)	5.3 (0.21)	9.7 (0.38)	62.0 (2.44)	217.2 (8.55)	206.0 (8.11)	116.3 (4.58)	18.0 (0.71)	3.6 (0.14)	7.6 (0.30)	679 (26.74)
Allahabad	97 m (322′)	-do-	21.6 (0.85)	16.0 (0.63)	14.2 (0.56)	4.3 (0.17)	16.0 (0.63)	128.0 (5.04)	319.0 (12.56)	254.8 (10.03)	212.3 (8.36)	59.4 (2.34)	7.9 (0.31)	8.6 (0.34)	1062 (41.82)
Lucknow	112 m (371′)	-do-	19.3 (0.76)	18.3 (0.72)	8.6 (0.34)	6.3 (0.25)	19.6 (0.77)	113.3 (4.46)	304.8 (12.00)	292.1 (11.50)	188.0 (7.40)	32.5 (1.28)	5.6 (0.22)	8.1 (0.32)	1016 (40.02)
Delhi	215 m (714′)	-do-	25.1 (0.99)	21.1 (0.83)	12.9 (0.51)	8.4 (0.33)	13.2 (0.52)	77.0 (3.03)	178.6 (7.03)	183.6 (7.22)	122.9 (4.48)	10.2 (0.40)	2.5 (0.10)	10.9 (0.43)	666 (26.24)

common to both regions. The 9 species recorded from the sub-mountainous tracts are also present in Himalayan region as well. To cite another example, the family Orchidaceae has 53 species in Dehra Dun and significantly, only one of these is found in the adjacent Indo-Gangetic Plain. There are many such examples. The numerous additions to the flora subsequently recorded in literature (*Raizada* 1931-62, *Murty & Singh* 1961, *Mukerjee* 1960, *Srivastava* 1955) also point to the same situation. A study of the localities of occurrence of these species shows that, of the nearly 240 species thus recorded, 95 are from Dehra Dun alone and many others are also from other sub-mountainous regions. The number of species recorded from the plains is comparatively very small.

In addition, the flora of Dehra Dun exhibits many unique features. The presence of swamps in the neighbourhood is another factor to be reckoned with because many unusual plants from higher regions may find repose in the sheltered swampy areas. It is well known that mountain plants have a wide range of altitudinal distribution and tolerance to varying conditions and the fact that some species normally occurring at altitudes of 1500 to 2000 metres on the Himalaya are also found in the Doon Valley at altitudes of 700 metres or less should cause no surprise. A list of such plants collected by the author from altitudes less than 1000 metres (also included by Duthie, Raizada and others) is given in Table II. Taking all these facts into consideration, it may be concluded that the Dehra Dun Valley is an exceptionally rich floristic area with close affinities to the Himalayan region.

It is also possible that some of the characteristic West Himalayan plants may appear now and then in favourable pockets in the swamps and other sheltered or climatically favourable spots in the Dehra Dun Valley and disappear after some time. Among examples of this kind are *Inula rubricaulis* collected by Gamble from the neighbourhood of Robbers' Cave, *Leucomeris spectabilis* collected by Royle from Siwaliks and by Kanjilal in Baruwala, *Quercus incana, Olea glandulifera, Symplocos crataegoides* and others recorded from swampy localities in Duthie's Flora. None of these species is present now in these localities as the records in the Herbaria and the recent studies of Dakshini (1965) and the writer's own observations indicate. This proves that, on account of similarity in climate, some of the purely Himalayan elements can grow in the Dehra Dun Valley but these can never survive in the plains. Only occasionally, one may come across a Himalayan plant in the plains, as for example, *Epilobium hirsutum* which was found along the Ganges canal from Rishikesh downwards. This species has also been recorded from Bhola Falls in Meerut District (*Murty & Singh* 1961).

TABLE II : *Recently collected plants (New for Indo-Gangetic Plains) from Dehra Dun Valley below 1000 metres*

(R: rare; C: common; VR: very rare; VC: very common; X: absent)

Sl. No.	Name of the Plant	Locality with author's collection number	Situation	Dun valley	West Himalaya	Base of Siwalik
1.	*Clematis grata* Wall.	near Robber's Cave (2840)	Open, sunny, spreading on bushes	R	R	X
2.	*Viola canescens* Wall.	Sahasradhara (1710), Kalinga Hills (2057)	Moist and shady	C	VC	X
3.	*Polygala cantoniensis* Lour.	Near Rajpur (1301)	Moist & shady position on clayey soil	R	VC	X
4.	*P. furcata* Royle	Sahasradhara (1102)	Moist rocks, shady position	R	C	X
5.	*Cerastium vulgatum* Linn.	Below Rajpur (2197)	On moist sandy bank of Raspana	R	VC	X
6.	*Stellaria paniculata* Edgew.	Near Rajpur (2964)	Moist and shady caves	R	C	X
7.	*Triumfetta annua* Linn.	Below Rajpur (2958), Mohand pass (1410)	Dry river bed shade of sal trees	R	VC	X
8.	*Geranium nepalense* Sweet	Raspana near Rajpur (369)	Moist river bed	R	VC	X

Sl. No.	Name of the Plants	Locality with author's collection number	Situation	Dun valley	West Himalaya	Base of Siwalik
9.	*Geranium rotundifolium* Linn.	Near Rajpur (2198)	Moist wall of canal	R	VC	X
10.	*Impatiens scabrida* DC.	Near Rajpur (790)	Moist caves	VR	VC	X
11.	*Boenninghausenia albiflora* Reichb.	Sahasradhara (1321)	Moist and shady walls of water channels	R	VC	X
12.	*Rhus cotinus* Linn.	Sahasradhara (2186)	Inside shady 'nalas'	VR	C	X
13.	*Argyrolobium flaccidum* Jaub. & Spach.	Raspana bed near Rajpur (1405)	Moist river bed	VR	R	X
14.	*Cassia laevigata* Willd.	Robber's Cave (2772)	Near houses in villages	R	C	X
15.	*Agrimonia eupatoria* Linn.	Rajpur, Sal Forest (2910)	On the fire line, sunny	VR	C	X
16.	*Argostemma verticillatum* Wall.	Rajpur (2709), Sahasradhara (2609)	Moist shady position often on tree trunks	R	VC	X
17.	*Randia tetrasperma* Benth. & Hk. f. ex Brandis	Robber's Cave (384), Near Rajpur (1563), Sahasradhara (2388)	On dry slopes, sunny or shady	R	C	X
18.	*Leptodermis lanceolata* Wall.	Near Rajpur (681), Sahasradhara (1092)	Moist and shady slopes often near water channels	C	C	X
19.	*Galium vestitum* Don	Sahasradhara (1331), (2688); Near Rajpur (1115), (2814)	Dry stony river bed or slopes	C	C	X
20.	*G. rotundifolium* Linn.	Sahasradhara (2674), Near Rajpur (2965), Robber's Cave (2136)	Sunny or shady position. Generally mixed with small shrubs.	R	C	X
21.	*G. aparine* Linn.	All over the Valley (391), (1345)	In moist shady, sal forests	C	C	X
22.	*Adenostemma lavenia* (Linn.) O. Ktze. var. *elata* Kitamura	Asarori (1262), Thano (3001)	In moist shady, sal forests	C	C	X
23.	*Erigeron mucronatus* DC.	Robber's Cave (1559), (2030)	On stone embankments near the river	R	VC	X
24.	*Laggera pterodonta* Benth.	Near Rajpur (1498)	On stones in river bed	R	C	X
25.	*Inula cuspidata* Clarke	Sahasradhara (1400)	Often along water channels	C	VC	X
26.	*I. eupatorioides* DC.	Near Rajpur (1528)	In dry river bed	R	C	X
27.	*Carpesium abrotanoides* Linn.	Sahasradhara (2870)	Undergrowth of shrubs	R	C	X
28.	*Gerbera lanuginosa* Benth.	Sahasradhara (2060)	On the grassy sides of 'nalas'	R	VC	X
29.	*Campanula colorata* Wall.	Robber's Cave (1323), Sahasradhara (1716)	Moist and shady positions	C	C	X
30.	*Lindernia nummularifolia* (D. Don) Wettst.	Near Rajpur (2846)	Openings inside sal forests	R	VC	X
31.	*Utricularia striatula* Sm.	Rajpur (1300)	On moist walls	R	VC	X
32.	*Chirita bifolia* Don	Sahasradhara (2675)	Moist and shady position along 'nalas'	R	VC	X
33.	*Plectranthus gerardianus* Benth.	Sahasradhara (1330)	Under growth of bushes, moist shady	C	VC	X
34.	*Coleus barbatus* Benth.	Sahasradhara (2869)	On dry rocks	R	C	X
35.	*Lamium amplexicaule* Linn.	Hardwar Road (817)	Weed in vegetable field	VR	C	X
36.	*Ajuga parviflora* Benth.	Sahasradhara (2063)	Between stones	R	C	X
37.	*Polygonum recumbens* Royle	Near Rajpur (2203), Sahasradhara (438)	On moist river beds	R	C	X

Sl. No.	Name of the Plants	Locality with author's collection number	Situation	Dun valley	West Himalaya	Base of Siwalik
38.	*Polygonum strigosum* R. Br.	Clement town (1280), Mathronwala (2885)	Along the water channels and in Rice fields	R	R	X
39.	*Taxillus vestitus* (Wall.) Danser	Sahasradhara (2192)	Along 'nalas' on several trees	R	C	X
40.	*Andrachne cordifolia* Muell.	Robber's Cave, Below Rajpur (1398), Sahasradhara (2047)	Mixed with hedges & other bushes	C	C	X
41.	*Phyllanthus debilis* Buch.-Ham.	Sahasradhara (2765)	Moist slope along the Road	R	C	X
42.	*Acalypha brachystachya* Buch.-Ham.	Rajpur, Sal Forest (127)	On the Fire line	R	C	X
43.	*Elatostema surculosum* Wight	Mohand pass (1091)	On walls of temple	R	C	X
44.	*Remusatia hookeriana* Schott	Below Rajpur (2518), (2672)	In sal forest in moist and shady spots	R	C	X
45.	*Rhaphidophora glauca* Schott	Robber's Cave (2580)	On stones	R	C	X

While including Dehra Dun and the sub-mountainous tracts within the scope of his Flora, Duthie also did not define the altitudinal limit within these tracts. This has led to varying interpretations for the limits of the Flora by subsequent workers while recording additions to the Flora. Duthie mentions several localities within the Dehra Dun district like Sahasradhara, Rajpur, Kalinga Hill, Robber's Cave etc., and if these localities are any indication for the altitudinal limit, a logical conclusion would be to include a large number of similar localities in the same altitudinal range which often penetrate deep into the Himalayan ranges. Raizada (1957) in his Grasses of the Upper Gangetic Plain (the title does not include the adjacent Siwalik and sub-Himalayan tracts), fixes the boundary as was done by Duthie "...on the north and north-east, it is bounded by a portion of Himalayas ... covering the State of Uttar Pradesh [including only the plains and sub-Himalayan mountain tracts of Garhwal and Kumaon up to 700 m (2300 ft) elevation]" (p. 172) and again while referring to the locality of occurrence of a species, "Dehra Dun, Gamble. The solitary specimen came from below Rajpur at 1000 m which is the extreme limit of our area" (p. 180). If the altitudinal limit of 700 m (2300 ft) is accepted as the boundary, then many of the localities which have contributed to a large extent to Duthie's Flora would have to be excluded; on the other hand if the limit of 1000 m (3300 ft) is accepted then many other localities will have to be brought in, some of which lie deep inside the outer Himalayan range.

The above account should be sufficient to impress that the inclusion of Dehra Dun and other sub-Himalayan tracts by Duthie has led to a large inbalance in the floristic composition and delineation of the limits of the flora of the region with the result that the real significance, composition and pattern of the flora of the plains has been largely obscured. The absence of a clear definition of the limits has led to the incorporation of many elements which are purely Himalayan and have very little to do with the flora of the plains.

The author after making an intensive study of the problem supported by field collections, wishes to emphasise that for writing a reliable and stable flora of the Upper Gangetic Plain a clear and natural boundary will have to be defined and as far as the northern limit is concerned, it can only be the base of the Siwaliks with a definite altitudinal limit. Regional Floras of large areas are written once in 50 or more years and their stability and usefulness will depend on how long they continue to represent the floristic composition of the area. In the absence of a clear and natural boundary the finding of new records will be a never ending process. It is, therefore, proposed that with the base of Siwaliks forming the northern boundary, the flora of the Upper Gangetic Plain will become a compact one with about only one third the number of species of the present flora and will still serve a vast region. The adjacent sub-montane tracts and the Dehra Dun Valley can be treated with the Himalayan region. This arrangement has already been followed in some of the regional floras published subsequent to Duthie's (*Kanjilal* 1901, 1909; *B. L. Gupta* 1928; *Osmaston* 1927). Hooker (Vol. 3, p. 389) likewise referring to the distribution of *Catamixis*, a plant found only in Siwaliks and nowhere else, stated "Western Himalaya, Garhwal on the Siwalik Hill". Duthie's fear expressed in the preface to his Flora that "It should also be borne in mind that a writer of Flora of the Western Himalaya might not be willing to take these particular tracts into his area; their inclusion therefore, in this flora will, at any rate, prevent the risk of their being altogether undealt with", thus appears to be unfounded. Duthie (1906) himself had included the plants collected from Dehra Dun, Rishikesh, Hardwar and many other localities in the list compiled by him under the title "The catalogue of the plants of Kumaon and adjacent portion of Garhwal and Tibet" based largely on the plants collected by Strachey and Winterbottom in Western Himalaya.

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